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RISK MANAGEMENT IN GLOBAL SUPPLY CHAIN NETWORKS

An Exploratory Study

Valtteri Väisänen

International Business
Bachelor's Thesis
Supervisor: Dr. Susan Grinsted
Date of approval: 8 April 2019

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ABSTRACT OF
BACHELOR'S THESIS

Author: Valtteri Väisänen
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Objectives
The main objectives of this study were to explore the sources and interconnectedness of supply chain risks and analyze risk management constructs and approaches. The objectives also included measuring which supply chain risk management strategies, and to which extent, are being used in different organizations.

Summary
This thesis provides more insight on how organizations operating in Finland view supply chain risk management. 18 organizations with global supply chain networks responded to an online survey conducted during the thesis process. The responses were analyzed and then compared to an ISO 31000 conceptual framework. The results showed the extent to which different organizations have adopted supply chain risk management practices.

Conclusions
Based on the findings of the survey, majority of the organizations believe supply chain risk management to be important and that it increases their organization's value. However, the degree to which these organizations practice supply chain risk management varies significantly. The analysis showed that organizations, which had suffered a significant impact on certain indicators, were now adopting more proactive risk management tools. Overall, the findings of this thesis are in line with previous research. Thus, this thesis provides more insight to the existing knowledge.

Key words: Supply chain risk management, ISO 31000, supply chain network, international business, SCRM

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1. INTRODUCTION

1.1. Background

Since 1945, and more particularly since 1990, globalization has increased dramatically. Free-trade agreements, liberalization of financial markets, and technological advancements have set the global GDP to skyrocket. Furthermore, rising economic powerhouses, such as China and India, have created an additional boost to the development. All this has also created longer and increasingly more complex and sophisticated global supply chains (SC).

However, more complex supply chain networks (SCN) also mean increased risk. While organizations have become aware of the risks related to their supply chain networks, they remain poorly prepared for managing it.

After the financial crisis in 2008, global SCs, trade, or foreign direct investments (FDI) have either stagnated or decreased and SCs are sourcing more regionally (The Economist, 2019). These changes in development may also create new risks and challenges for supply chain management (SCM). New boundaries, stagnation, or reverse development in global economy might be unexpected, which is why organizations could remain unprepared for them. However, it is ever more crucial for organizations to manage their SCs effectively, considering the role of SCs in the global trade.

Ignoring potential risks in SC can reduce shareholder value significantly (Dittman et al., 2010). However, most organizations ignore this aspect due to the additional costs related to risk management (Jüttner et al., 2003). New technology can help organizations to improve their supply chain risk management (SCRM) and create new, innovative ways of creating SCRM strategies (Tohamy, 2008; Dittman et al., 2010; Alvarenga, 2012). Furthermore, integrating risk management in supply chain networks to the daily operations can generate more shareholder value (Trkman et al., 2016). Therefore, it is in the interest of the owners to address this issue properly.

This thesis aims to formulate a broad understanding of risk management in global supply chain networks. Furthermore, this thesis aims to understand how organizations operating in Finland manage their SCs.

1.2. Research Problem

While current research identifies multiple types of risk and their effects, more research could be done on how well prepared organizations are for SCRM. New technology can help organizations to improve their risk management and create new, innovative ways of creating risk management strategies (Tohamy, 2008; Dittman et al., 2010; Alvarenga, 2012). Furthermore, integrating risk management in supply networks to the daily operations can generate more shareholder value and create more resilient SCs (Trkman et al., 2016).

1.3. Research Questions

This thesis explores the issue of formulating a risk management strategy for global supply chain networks. Based on previous research and literature on the topic, different processes to identify, manage, and avoid risks are investigated. Specifically, this thesis explores the following questions:

1. What are the sources of different types of risk and their relations in global supply chains?
2. How can supply chain risk management lead to increased value and competitive advantage?
3. How can organizations transform supply chain risk management being reactive to proactive?
4. How are organizations operating in Finland deploying SCRM strategies?

1.4. Research Objectives

Specifically, the research objectives of this thesis are to:

- Explore the sources of risk types and their interconnectedness.
- Analyze risk elimination mitigating approaches in global supply networks.
- Examine the basic constructs of risk management.
- Measure, which risk management strategies are being used in different organizations.
- Investigate ways of integrating risk management to the daily operations of an organization.

1.5. Thesis Structure

After introduction, literature review will discuss previously conducted research on SCRM and introduce a conceptual framework. Next, methodology section will introduce and explain the methodology used in this bachelor's thesis, followed by the findings from the survey. Third, the findings are discussed and analyzed, followed by limitations, implications for international business, and suggestions for future research.

2. LITERATURE REVIEW

2.1. Introduction

Global SCs and SCRM have gained plenty of attention in academia, business, and media alike over the past years. Research on the topic has focused on a large variety of industries, geographic areas, and different stages of a SCN.

This literature review focuses on analyzing previously conducted research on SCRM, identifies risk management models, and the outcomes of integrated SCRM processes. This paper will also identify overall trends related to supply chain risk management, and its use in developing strategy and in decision-making.

2.2. Supply Chain Risk Management

Supply chains handle the flow of information and products in all stages of the chain. However, SCs are also subject to various risks. These risks may occur both upstream and downstream, at a specific stage of the SC, or arise from outside or within the SC (e.g. Manuj & Mentzer, 2008; Jüttner & Maklan, 2011; Prakash et al., 2017; Fan & Stevenson, 2018).

SCRM is a formal process to establish strategies for the identification, assessment, treatment, and monitoring of risks in supply chains (Neiger et al., 2009; Tummala & Schoenherr, 2011; de Oliveira et al., 2017; Fan & Stevenson, 2018). Previous research of SCRM has focused on a variety of issues, such as SC security, information system risk, SC resilience, or the process of risk identification (Jüttner & Maklan, 2011; Prakash et al., 2017).

Global SCs are prone to a large variety of SC risks, risk sources, SC complexity, and a high level of interconnectedness. These factors also make SCRM particularly demanding to be successful. Nevertheless, SCRM should be a high priority in global organizations due to the severe consequences of risk actualization.

2.3. Risk Management Process

Supply chain risk management process (RMP) is a model, which defines methods for risk management. The model can also be used in formatting a risk management action plan and integrating it into the daily operations of an organization.

There are many SCRM models, many of which divide the process into similar stages (e.g. Manuj & Mentzer, 2008; Tummala & Schoenherr, 2011; de Oliveira et al., 2017; Prakash et al., 2017). Usually the RMP is divided into three or four phases. According to Tummala and Schoenherr (2011), as seen in more detail in Figure 1, these phases are

1. Risk identification, measurement, and assessment

2. Risk evaluation and mitigation
3. Risk control and monitoring

The model gives a basic overview of SCRM and identifies different components affecting the different phases of the RMP. Phase 1 is influenced by different "internal" drivers, such as company's current situation, and "external" drivers, such as competitive environment, depending on where the risk originates. Similarly, Pfohl et al. (2010) identifies risks either from outside the company, within the company, or within the SC, depending on where the source of the risk is.

Furthermore, the model gives examples of potential risk categories, such as demand or supply risk. Phase 2 also identifies different risk evaluation and performance measurement criteria, such as reliability or financial condition. However, the model does not differentiate clearly between risk elimination and mitigation. Tummala and Schoenherr (2011) use hazard totem pole analysis (HTP) to evaluate SC risks. Based on the values given by the HTP analysis, proper risk treatment approach is chosen. The first step is to try to eliminate the risk. If elimination is not possible, the risk should be mitigated (Tummala & Schoenherr, 2011; Aqlan & Lam, 2015; Fan & Stevenson, 2018).

Likewise, Hachicha and Elmsalmi (2014) divide the process into four stages:

1. Risk identification
2. Risk assessment
3. Risk management decisions and implementation
4. Risk monitoring

There is also an ISO 31000 standard for risk management, which can also be used in SCRM. The ISO 31000 RMP divides the process into seven stages as seen in Figure 2 and takes into consideration that the use and interpretation of it varies across different organizations and industries (de Oliveira et al., 2017). Nevertheless, all of the RMP models are very general by nature, which affects their usability depending on the industry, or individual organization.

In the ISO 31000, communication and consultation between all parties of the SC continues throughout the RMP. The purpose of this is to ensure that all parties affected understand the reasons in the decision-making (de Oliveira et al., 2017). Furthermore, communication increases transparency in complex SCs, which is crucial due to the subjective nature of risk assessment.

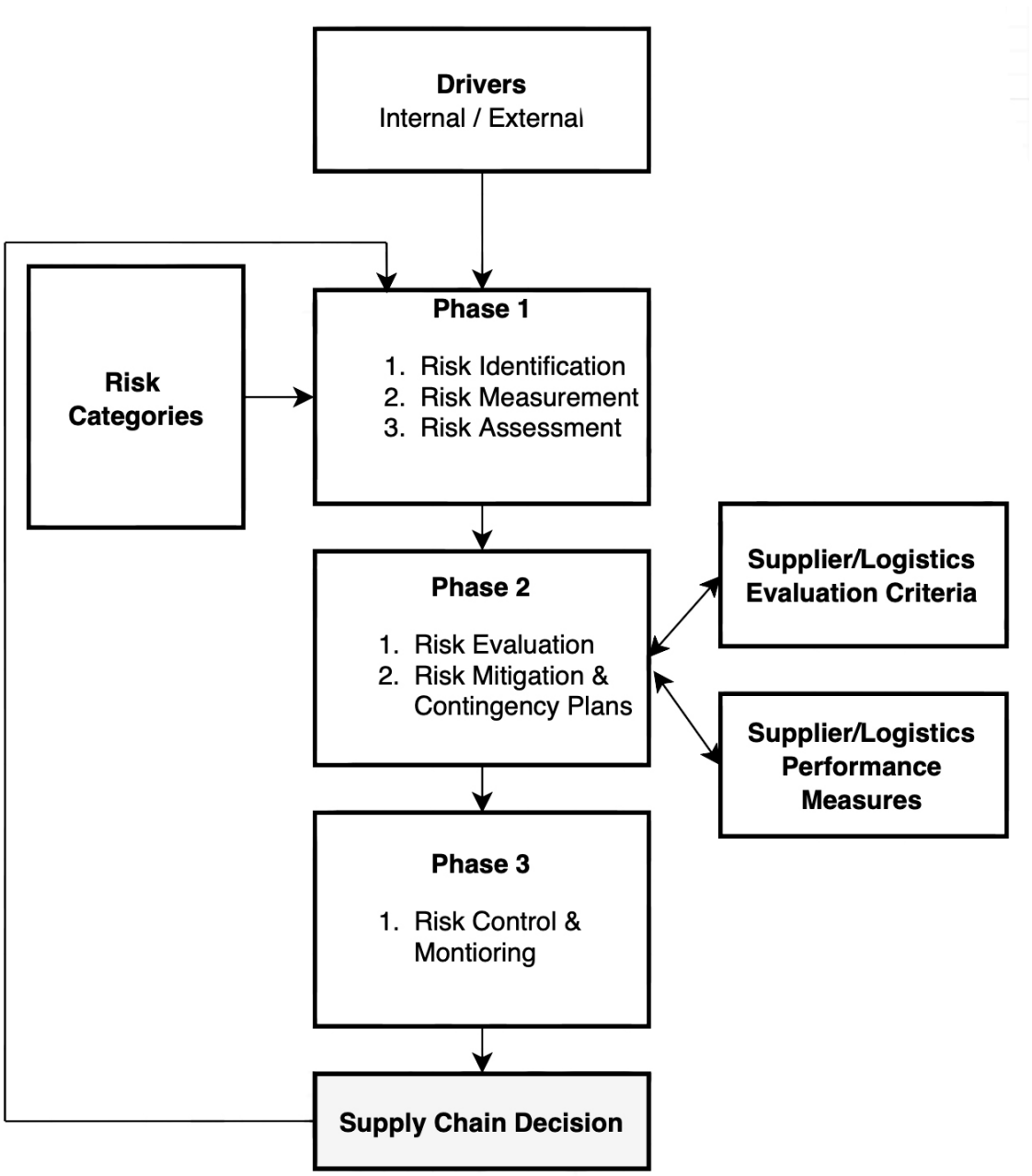

Figure 1: SCRM Process (Tummala & Schoenherr, 2011).

Similarly, monitoring and critical review continues at all stages of the RMP. The purpose of monitoring and critical review is to establish pre-defined responsibilities for each party in the SC, assure effective and efficient operations, and identify and analyze emerging risks. Establishment of the context includes stating organization's objectives for SCRM and defining the external and internal drivers for risks (de Oliveira et al., 2017).

In the ISO 31000 standard, risk treatment covers all possible risk treatment strategies: elimination, mitigation, and acceptance.

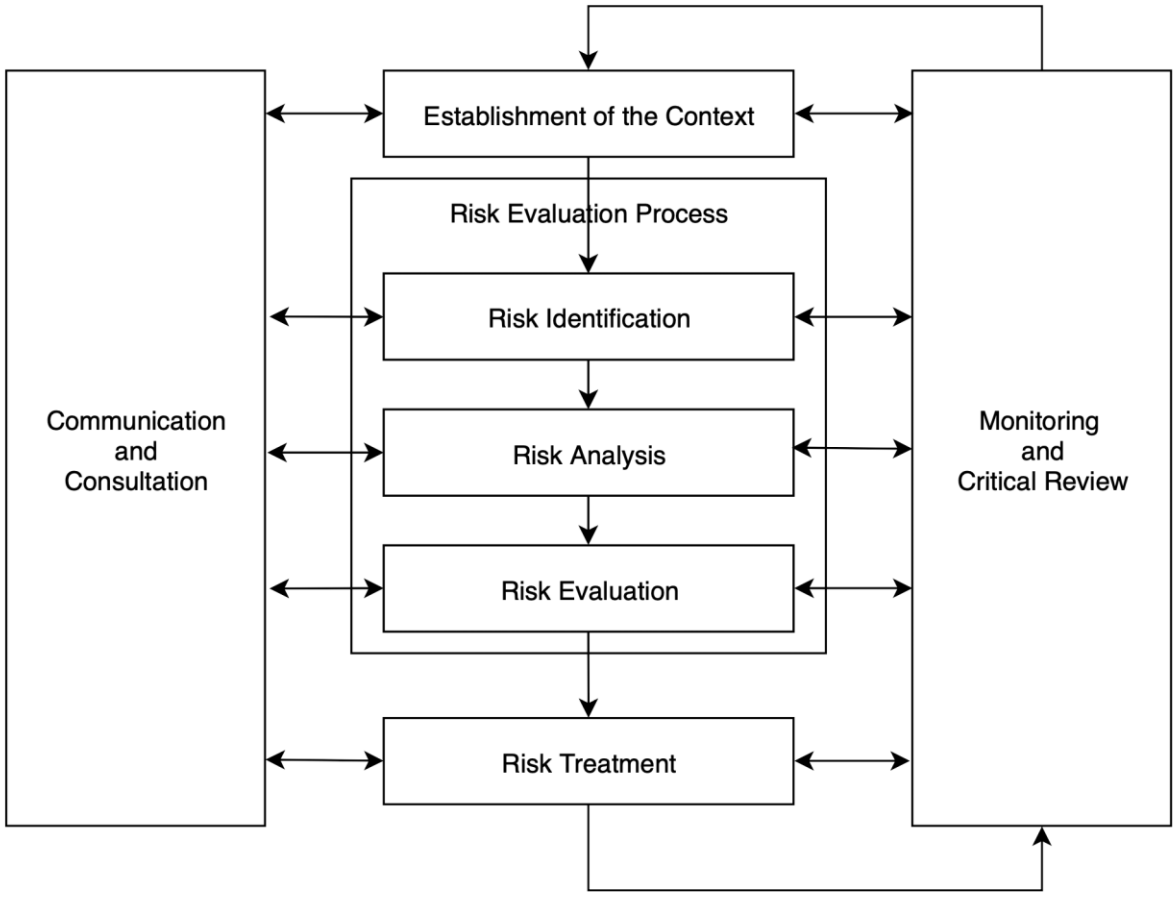

Figure 2: ISO 31000:2009 Risk Management Standard (de Oliveira et al., 2017).

2.4. Risk Identification

There is no universally accepted definition for supply chain risk (SCR). Ho et al. (2015) defines SCR as "the likelihood and impact of unexpected macro and/or micro

level events or conditions that adversely influence any part of a supply chain leading to operational, tactical, or strategic level failures or irregularities." Jüttner et al. (2003) recognizes that the term "risk" can refer to uncertainty or the actual outcomes of an event. Whereas Manuj and Mentzer (2008) see risk primarily as a financial issue by defining risk through potential losses and the likelihood of those losses.

Tummala and Schoenherr (2011) define SCR as "an event that adversely affects supply chain operations and hence its desired performance measures, such as chain-wide service levels and responsiveness, as well as cost". Risk can also be described as a formula, where risk equals to the probability of the event (P) multiplied by the impact (L) of the event (Aqlan & Lam, 2015).

The risk sources are usually classified as internal or external (Pfohl et al., 2010; Tummala & Schoenherr, 2011; Prakash et al., 2017; Jajja et al., 2018). Internal risk drivers can arise from an organization's past, such as experiences, present actions, or future plans. Whereas external risks derive from the operating environment. Additionally, Christopher and Peck (2004) classify SC risk sources into three categories:

1. Internal: processes and control risk
2. External to the organization, but internal to the SC: demand and supply risk
3. External to the SC: environmental risk

In Christopher and Peck's model, the external sources of risk affect to both stages one and two. Similarly, Manuj and Mentzer (2008) identify three risk sources: supply risks, operational risks, and demand risks. Both local and global operating environments affect all three areas of risk.

The external drivers for risk are, for instance, emerging new markets, or changes in competitive situation, politics, or economy (Tummala & Schoenherr, 2011). Often external sources of risk are related to macro-level incidents beyond an organization's control, such as natural disasters or economic crises (Prakash et al., 2017). Furthermore, Fan and Stevenson (2018) categorize SC risk sources as "Probability" and "Impact" drivers, based on the risk source's impact on the SC's vulnerability or the

magnitude of potential losses, respectively. Moreover, risk sources can also be both probability and impact drivers simultaneously (Fan & Stevenson, 2018).

2.4.1. Risk Characterization

SCR can be further classified to different categories based on their characteristics, such as security, capacity, financial, economic, political, geographic, environmental, or competitive (e.g. Jüttner et al., 2003; Tummala & Schoenherr, 2011; Ho et al., 2015; Prakash et al., 2017; Jajja et al., 2018). The purpose of risk characterization is to serve as a basis for decision-making in SCRM (de Oliveira et al., 2017) and prepare the organization to improve their risk management in the future (Fan & Stevenson, 2018). Characterization allows determining the sources of risk, which in turn helps to eliminate or mitigate the risk. However, some risk types, particularly external macro-risks, can be out of an organization's reach to eliminate.

After risk characterization, the potential consequences, magnitude, and impact of the risk are determined (Tummala & Schoenherr, 2011). The consequences can be further classified based on their frequency, severity, or predictability (Tummala & Schoenherr, 2011; de Oliveira et al., 2017).

2.5. Risk Assessment

After identifying SC risks, the identified risks are assessed and prioritized. Risk assessment and prioritization helps to determine the broadness of its impact in the SC and prioritize between risk treatment order and elimination or mitigation, and make sure that the RMP is effective (de Oliveira et al., 2017; Fan & Stevenson, 2018). Organizations mostly prioritize the risks based on their interconnectedness, consequences, and probability (Purdy, 2010; Hachicha & Elmsalmi, 2014; Rangel et al., 2015; de Oliveira et al., 2017; Fan & Stevenson, 2018). The interconnectedness and multiple levels of a SC increase its vulnerability and make it more sensitive for turmoil (Jüttner et al., 2003; Pfohl et al., 2010; Min, 2019). The more connected the risk is to other potential risks, or to other parts of the SC, the more critical it is to prioritize it in the RMP.

The assessment of consequences and probability of a risk factor can be based on both objective and subjective information (Tummala & Schoenherr, 2011; Rangel et al., 2015). If objective information is available, the probability and consequences can be determined accurately (Tummala & Schoenherr, 2011; Prakash et al., 2017). Otherwise, the assessment is based on judgment, reasoning, experience, etc. The available information for risk assessment can also be referred to as quantitative or qualitative (Purdy, 2010; Tummala & Schoenherr, 2011; Park et al., 2013). Nevertheless, the use of quantitative and qualitative information is in most cases the same as with objective and subjective information.

When there is no objective or quantitative information available, identifying risks, potential consequences, frequency, or magnitude can be difficult (Purdy, 2010; Tummala & Schoenherr, 2011). In such cases, qualitative, or subjective, analysis is implemented (Tummala & Schoenherr, 2011; Rangel et al., 2015). It is also worth noting that quantitative information is not always objective, or qualitative information subjective (Park et al., 2013). Such examples, for instance, could be estimating the financial damage of leaking intellectual property (IP) information.

The U.S. Department of Defense (DoD) Military Standard 882E can also be used in qualitative SC risk identification and assessment (Tummala & Schoenherr, 2011; Department of Defense, 2012). The risks are categorized based on their probability and impact, and often visualized as a risk matrix (Table 1). The matrix model helps to prioritize the risks and start the RMP especially if objective information is not available. Risks with critical or catastrophic severity and occasional, probable, or frequent probability are the most severe risk types. No organization have the resources to eliminate every potential risk. Therefore, risks with the highest probability and most severe consequences should be eliminated first (Aqlan & Lam, 2015; Fan & Stevenson, 2018).

Measuring SC risks covers financial losses caused by the risk, damaged assets, interruptions, delays, or poor performance levels (Tummala & Schoenherr, 2011; Aqlan & Lam, 2015). Measuring SC risks quantitatively helps to compare and priori-

tize them. Moreover, quantitative risk measures help to compare the cost of SC risks to cost of SCRM.

RISK ASSESSMENT MATRIX				
SEVERITY → / PROBABILITY ↓	Catastrophic (1)	Critical (2)	Marginal (3)	Neglible (4)
Frequent (A)	High	High	Serious	Medium
Probable (B)	High	High	Serious	Medium
Occasional (C)	High	Serious	Medium	Low
Remote (D)	Serious	Medium	Medium	Low
Improbable (E)	Medium	Medium	Medium	Low
Eliminated (F)	Eliminated.			

Table 1: Military Standard 882E risk assessment matrix (Department of Defense, 2012).

The risk assessment process throughout the SC is very complex and requires understanding of second and third tier supply chains (Jüttner et al., 2003). Understanding the SCs structure thoroughly has become more crucial than ever to successfully conduct risk assessment. Furthermore, the increased complexity in global SC's indicates how costly and time-consuming a thorough risk assessment is. However, poor risk assessment increases the vulnerability of the SC (Jüttner et al., 2003; Min, 2019). Therefore, it is in the organization's interest to invest in a proper risk assessment process.

Even though risk assessment is a relatively simple process, there are some challenges to it. Increased complexity of global SCs reduces transparency and, thus, makes SCR assessment difficult. Thorough risk assessment requires a significant amount of resources. Furthermore, lack of information, both objective and subjective, complicates the risk assessment process significantly.

The challenges in SCR assessment process can be divided into three categories: design, subjectivity, and coordination problems (Park et al., 2013). Design risk refers to the lack of universal risk assessment model, which may result in poorly planned and executed risk assessment in an organization. However, creating a universal risk assessment model is difficult due to the situation-specific nature of SCRM (Manuj & Mentzer, 2008; Park et al., 2013).

Subjectivity problem indicates the subjective nature of knowledge, behavior, or perceiving risk (Jüttner et al., 2003; Park et al., 2013). Coordination problem refers to the process of gathering information from the SC. The coordination of this process can be difficult due to the complexity and lack of visibility in the SC.

2.6. Risk Treatment

The next phase in the RMP is to adopt a risk treatment approach. The main objective is to change the significance or probability of the consequences (Purdy, 2010). Furthermore, a risk management strategy is developed based on the chosen risk treatment approach. Fan and Stevenson (2018) identified five risk treatment types:

1. Risk acceptance. An organization tolerates a certain amount of risk and bears the consequences.
2. Risk elimination. An organization treats the risk by avoiding the risk factor.
3. Risk transfer. An organization transfers the risk to another party through insurance, for instance.
4. Risk sharing. An organization reduces the impact of the risk by sharing the consequences with another party.
5. Risk mitigation. An organization attempts to reduce the risk by reducing both the probability and consequences of a risk.

Park et al. (2013) point out that risk mitigation can be either direct or indirect. Compared to the risk treatment types identified by Fan and Stevenson (2018), everything except risk acceptance and risk elimination are identified as risk mitigation.

Choosing a proper risk treatment approach depends on the situation and varies even within the same SC. Additionally, the chosen approach might change during the process. For instance, risk acceptance does not necessarily mean that an organization would accept any level of risk. Instead, the approach might change to some other approach when the risk becomes too high (Aqlan & Lam, 2015; Fan and Stevenson, 2018). It is also worth noting that sometimes organizations might decide to take advantage of an increased risk to seek for an opportunity (Manuj & Mentzer, 2008; Purdy, 2010; Aqlan & Lam, 2015). However, in the long run it is in an organization's interest to eliminate risks instead of choosing to mitigate.

Additionally, Manuj and Mentzer (2008) also identify postponement and hedging as a SCRM strategy. They define postponement as a "way of delaying the actual commitment of resources to maintain flexibility". In practice, this could be, for instance, manufacturing or distributing products only after a customer has placed an order. However, postponement can be an expensive strategy in a global SC, due to long distances and logistics. Similarly, hedging can be an expensive strategy due to the high costs of maintaining similar SCs simultaneously (Manuj & Mentzer, 2008). Yet, it reduces an organization's reliability on individual suppliers and, thus, eliminate a potential risk.

2.7. Developing a Risk Management Strategy

The purpose of creating a risk management strategy is to develop a clear roadmap to follow and achieve the desired risk treatment outcome. SCRM strategy also includes implementation and monitoring plans (e.g. Purdy, 2010; Rangel et al., 2015; Rajesh et al., 2015; Min, 2019). When forming a strategy, different methods, goals, or approaches should be presented (Prakash et al., 2017). To succeed, SCRM strategy should be integrated to the supply chain management and the corporate strategy and culture (Pfohl et al., 2010; McKinnon, 2014; Christopher, 2018). In addition, large and complex supply chains might require multiple SCRM strategies, which are applied in a hierarchical order or simultaneously (Purdy, 2010).

For instance, SC security strategy can be implemented simultaneously with other SCRM strategies. The purpose of security strategy is to identify abnormalities and suspicious circumstances in order to protect from security threats, such as crime, terrorism, or information leaks (Manuj & Mentzer, 2008).

De Oliveira et al. (2017) classify risk management strategies as reactive or proactive. Proactive SCRM aims to eliminate or minimize the probability of a risk factor or the potential consequences. Reactive strategies, in turn, manage the risk when the identified risk has already occurred. Both risk management strategies begin from identification and assessment of potential risks. Based on their probability and impact, organizations choose between proactive and reactive strategies.

Furthermore, proactive measures, such as use of risk scenarios, previous experiences and collected data, or simulations can help to measure and improve SC resilience and flexibility (Deloitte, 2013; de Oliveira et al., 2014; Christopher, 2018). Therefore, despite being expensive for organizations, proactive measures can lead to increased value-creation through more efficient and effective SCRM.

When formulating a SCRM strategy, attention should be paid to SC resilience, flexibility, implementation, and value creation (Manuj & Mentzer, 2008; Pfohl et al., 2010; Ho et al., 2015; Min, 2019). Flexibility and resilience of a SC are particularly important, as they improve the SC's ability to response fast to changes in the operating environment. In addition to the formal SCRM process, resilience can be improved through multiple additional steps, such as conducting stress tests, increasing agility, and increasing collaboration and sharing information with other parties in the SC (McKinnon, 2014).

A model created by Manuj and Mentzer (2008) suggests that when adopting a proper SCRM strategy, three factors should be considered: temporal focus, SC flexibility, and SC environment. Temporal focus is a short-term perspective leading to strategies with prompt results. According to Manuj and Mentzer (2008), adoption of temporal focus suggests a low importance to risk management. In addition, a management team composition affects the strategy selection, which, together with the SC complexity, affect the risk management consequences (Manuj & Mentzer, 2008).

Therefore, it is important to acknowledge the benefits of composing diverse risk management teams.

Furthermore, in order to implement SCRM strategies successfully, a high level of communication, information sharing, knowledge comparison, and learning abilities are required (Jüttner et al., 2003; Manuj & Mentzer, 2008; de Oliveira et al., 2017). The implementation process can be formal, informal, or both (Park et al., 2013). However, due to the clear structure, formal implementation is more efficient for an organization. Additionally, the chosen strategies should be collaborative and continuously improved based on previous experiences and findings discovered through monitoring the SCRM processes.

2.8. Conclusions and Conceptual Framework

Based on the large amount of research on SCRM, the variety of risks, risk sources, as well as the increased complexity of global supply chains make it particularly demanding to manage successfully. SCRM is a multistage process, which requires thorough analysis especially in assessing the identified risks. However, SCs are prone to face surprises and undiscovered risks. Therefore, SCRM strategies should highlight SC resilience, recovery, and flexibility.

According to a Deloitte survey (2013), 66% of companies have established a RMP, but only 50% believed those programs to be effective. Furthermore, only one third of the companies used proactive SCRM strategies. While current research identifies SCRM models, multiple types of risk and their effects, more research could be done on formulating a risk management strategy. More research could also be done on SCRM process integration and the creation of detailed and successful implementation plans for SCRM strategies. Moreover, research on how SCRM and SC resilience can lead to increased value, and how to measure it, should be done.

Based on the different frameworks introduced in this literature review, the ISO 31000 standard (Figure 2) has the most comprehensive approach towards risk management. The framework describes the necessary stages of a SCRM process and iden-

tifies factors affecting them. Despite the general nature of the framework, the ISO 31000 standard is applicable to any organization regardless of size or industry. Therefore, the ISO 31000 standard will be used as a reference for conceptual framework in this thesis, when analyzing the findings of the research.

3. METHODOLOGY

This thesis is based on both secondary and primary data. Secondary data was discussed in the literature review and was used in developing an overview of SCRM and identifying a conceptual framework. Collecting primary data aims to further understand, add knowledge, and confirm or challenge what was discussed in the literature review.

The research process is usually defined as a multi-stage process, which consists of the following phases: formulation of topic, literature review, research outline, data collection, and analysis (Saunders et al., 2007). Sections one and two of this thesis covered the first two stages of the research process. This section will examine different research methods, analyze the research design, explain the data collection stage, and identify limitations of the chosen methodology.

3.1. Research Methods

Both qualitative and quantitative methods have been widely used in SCRM research. Qualitative methods, such as interviews, are commonly used when adopting inductive approach. Inductive reasoning aims first to gather data through observation in order to understand the meanings behind the research context (Saunders et al., 2007). Inductive reasoning is usually used together with qualitative methods, such as interviews. However, sometimes also questionnaires are used with inductive reasoning, when surveying subjective and exploratory information. Due to the subjective nature of qualitative research, the findings cannot be generalized. Other qualitative methods, in addition to interviews, are observing, focus group discussions, or open-ended questionnaires (Saunders et al., 2007).

Deductive reasoning, however, is often used when the research aims to find generalized conclusions through quantitative methods (Saunders et al., 2007). Quantitative methods generate numerical data and is thus considered more objective. However, it fails to provide intuitive information of a single individual or context.

Choosing a suitable research method is important in order to answer the research questions and reach the objectives of this thesis. It is also worth reminding to consider the limitations of the bachelor's thesis process, such as limited time period and feasibility. While interviews are a commonly used method in SCRM research, it was not used in this thesis due to time constraints. As the objective of this thesis is to add knowledge of the topic, quantitative methods seemed more suitable.

The chosen research method was to conduct an online survey. Conducting a survey allowed to reach more organizations within a short period of time. Furthermore, the survey provided numerical and measurable data for analysis, which seemed suitable considering the objectives of this thesis. Moreover, surveys were also used in many of the studies discussed in the literature review. Due to the exploratory nature of the research, where subjective information is gathered and compared to the conceptual framework, this thesis uses inductive approach.

3.2. Research Design and Sample Selection

The survey was conducted in a form of a questionnaire (Appendix 1), which was designed using Webropol survey tool. The questionnaire design was based on multiple previously conducted surveys on the same topic. Research conducted by Jajja et al. (2018) served as a model for designing the questionnaire and conducting the survey. Also, Hillman and Keltz (2007) have conducted a quantitative study on SCRM and served as a basis for the questionnaire. In addition, SCRM studies conducted by PwC (2013) and Deloitte (2013) were used as a reference when designing the questionnaire.

The aim of the survey was to identify SCRM practices in different organizations, determine, which risk categories were considered as the most important, understand how SC disruptions have affected these organizations, and gain insight on how these organizations view SCRM.

The questionnaire consisted of 16 questions. On the first page, respondents were first asked to evaluate the development of the supply chain complexity. This was measured using a five-point Likert Scale where respondents indicated to what degree they agreed with each of the five statements. Respondents were then asked to rank the first, second, and third most important risks for their organization from a list. The third question measured whether the respondent's organization had suffered significant impact on specified indicators, such as market value, over the past 12 months.

Questions 4 to 10 of the questionnaire identified estimated trends of SC risk categories, the level of prioritization of SCRM, SCRM actions and capabilities, and challenges to effective SCRM. Question 8 measured on a five-point Likert Scale the effectiveness of SCRM in the respondent's organization.

Question 11 identified, which SCRM components the surveyed organizations were already using, planning to use, or whether there were no plans to use a specific SCRM component. Questions 12 to 14 measured general information, whether SCRM was seen as an important part of strategic decision-making process, whether SCRM had increased the organization's value, and about the funding of SCRM activities. Question 15 identified the industry in which the respondent's organization was operating and question 16 was an open-ended question, in case the respondent had any additional comments to make.

The sampling was based on non-probability sampling. The used sampling method was self-selection sampling. Respondents were searched via LinkedIn, after which they were contacted by email and asked to participate in the survey. Search filters used on LinkedIn included different company names, and terms "supply chain", "logistics", or "operations" to specify the potential respondent's title. In some cases,

when individual contact information was not found, the request was sent by email to a general inquiry address of an organization.

Sampling was based on the following criteria:

1. The organization has an office in Finland
2. The organization has international operations and supply chains
3. The contact person's job description was related to supply chains

The size of an organization or an industry were not specified. In addition, the responses were gathered via a public link, which ensured the respondent's anonymity as it made tracing the answer's source impossible.

The survey aims to identify, to what extent organizations are using proactive SCRM strategies and the degree of SC resilience, as identified in the conceptual framework.

3.3. Data Collection and Coding

Before sending out the questionnaire, the survey was tested to see whether it had any errors, ambiguity, or other areas of improvement. Based on the feedback from the test respondents, the questionnaire was revised and tested again before distributing. All responses were voluntary, and respondents were ensured anonymity before answering. Furthermore, the purpose of the data collection as a part of a bachelor's thesis was expressed clearly.

In total, the questionnaire was sent out to 144 representatives of an organization, 18 of which responded. Therefore, the response rate was 12,5%. One of the respondents did not answer all of the questions. The responses were downloaded from Webropol, which coded the responses automatically for SPSS format.

In SPSS, the responses were labeled, categorized and given a numerical value. For instance, Likert Scale responses were coded from 1 to 5, where 1 = Strongly Agree and 5 = Strongly Disagree.

3.4. Limitations of Methodology

As always, the chosen methodology is restrained by some limitations. Firstly, the process of searching for potential respondents online and reaching out to them individually was a time-consuming process. Low response rate indicates that receiving emails to participate in a bachelor's thesis survey might not be the most effective way to gather responses. Furthermore, it is worth reminding that due to the sampling method, the responses are not fully representative. Therefore, the responses cannot be generalized to represent all organizations.

Second, despite gathering numerical data, the responses in the questionnaire are very subjective. Many of the questions in the questionnaire leave room for interpretation, since terms such as "significant" "very important", or "effectively managed" were not defined.

Third, since the survey was conducted in English, there might have been a language barrier with some of the Finnish-speaking respondents due to varying levels of proficiency. Lastly, due to the chosen method, an online survey, respondents did not have a chance to ask any questions, in case they had any.

4. FINDINGS

This section discusses the findings of the research. First, the sample is described and analyzed, and findings of the survey are described. Last, some computation based on the findings is conducted using SPSS software.

4.1. Description of Findings

4.1.1. Reliability Analysis

First, a reliability test was conducted using SPSS for the whole survey, as well as for each of the responses. Reliability was measured using Cronbach's alpha. Generally,

$\alpha > 0{,}70$ is considered acceptable. However, some of the research on SCRM considers $\alpha > 0{,}60$ acceptable (Revilla & Sáenz, 2014; Jajja et al., 2018). In this research, alpha of 0,66 (Table 2) indicates that the responses of the questionnaire have rather low consistency. Nevertheless, reliability of this survey can be considered acceptable, since similar research on SCRM has consistently reached $\alpha > 0{,}70$ (Revilla & Sáenz, 2014; Wiengarten et al., 2016; Jajja et al., 2018). Furthermore, rather low internal consistency was expected due to the exploratory and subjective nature of the survey.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,666	,573	98

Table 2: Reliability statistics of the survey.

According to item-total statistics (Table 3), removing individual items would have led to a decrease of alpha, or only a minor increase. However, removal of question 10 “Does your organization deploy an official supply chain risk management strategy?” would increase the alpha to 0,69 and, thus, increase the reliability by little. However, since the change would have only a minor improvement in the reliability of the findings, all questions are included in the data-analysis.

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Does your organization deploy an official supply chain risk management strategy?	115,2500	201,400	-,271	.	,690

Table 3: Cronbach’s alpha if Question 10 was removed.

4.1.2. Supply Chain Complexity

Respondents were asked to evaluate the development of SC complexity over the past three years by answering to five statements. According to the findings, 88,9% of respondents either strongly agreed or agreed that dependencies between SC parties had increased over the past three years (Table 4).

		Frequency	Percent	Valid Percent	Cumulative Percent
Dependencies between supply chain parties have increased	Strongly Agree	6	33,3	33,3	33,3
	Agree	10	55,6	55,6	88,9
	Neither Agree or Disagree	2	11,1	11,1	100,0
	Total	18	100,0	100,0	

Table 4: 88,9% of respondents agreed that SC parties had become more dependent of each other.

According to the survey, 77,8% of the respondents agreed that changes in SC configuration occur more frequently, while 77,8% stated that the number of SC parties had either increased or remained the same over the past three years. Respondents also felt that SCs have become more transparent. Only 16,7% of the respondents agreed, and none strongly agreed, to the statement that relationships between SC parties had become less transparent. Finally, 83,3% of the respondents either strongly agreed or agreed that SC collaboration had increased over the past three years (Table 5).

Respondents considered supplier failure as the most important risk, with 11 responses. Price fluctuations was considered as the 2nd most important with 7 responses, while supplier failure with six and changes in regulations with four responses came close. Geopolitical instability was considered being the 3rd most important risk with six responses. Also, natural disasters and border delays were considered as 3rd most important risk by many, both receiving four responses (Table 6).

		Frequency	Percent	Valid Percent	Cumulative Percent
Changes in supply chain configuration occur more frequently	Strongly Agree	2	11,1	11,1	11,1
	Agree	12	66,7	66,7	77,8
	Neither Agree or Disagree	2	11,1	11,1	88,9
	Disagree	2	11,1	11,1	100,0
	Total	18	100,0	100,0	
The number of parties in the supply chain has increased	Strongly Agree	4	22,2	22,2	22,2
	Agree	4	22,2	22,2	44,4
	Neither Agree or Disagree	6	33,3	33,3	77,8
	Disagree	4	22,2	22,2	100,0
	Total	18	100,0	100,0	
The relationships between supply chain parties have become less transparent	Agree	3	16,7	16,7	16,7
	Neither Agree or Disagree	4	22,2	22,2	38,9
	Disagree	9	50,0	50,0	88,9
	Strongly Disagree	2	11,1	11,1	100,0
	Total	18	100,0	100,0	
Collaboration between supply chain parties has increased	Strongly Agree	3	16,7	16,7	16,7
	Agree	12	66,7	66,7	83,3
	Neither Agree or Disagree	2	11,1	11,1	94,4
	Disagree	1	5,6	5,6	100,0
	Total	18	100,0	100,0	

Table 5: Responses to the development of SC complexity.

	Ranked 1	Ranked 2	Ranked 3
Supplier failure	11	6	0
Border delays	0	1	4
Failure of company-owned supply chain operations	2	2	3
Price fluctuations	2	7	3
Natural disasters	0	1	4

Geopolitical instability	0	2	6
Corruption	0	1	3
Changes in regulations	4	4	0
Strategic risk	3	2	3
Intellectual property theft or infringement	0	3	1
IT disruptions	1	3	3
Cyber attacks	1	2	2
Other	0	0	3

Table 6: 1st, 2nd, and 3rd most important risks.

Based on the results, 69% of the respondents have suffered a significant impact on order fulfillment lead time because of SC disruptions. Furthermore, 50% of the respondents stated that they had suffered significant impact on SC cost, 38% on inventory turnover, and 25% on sales revenue (Figure 3).

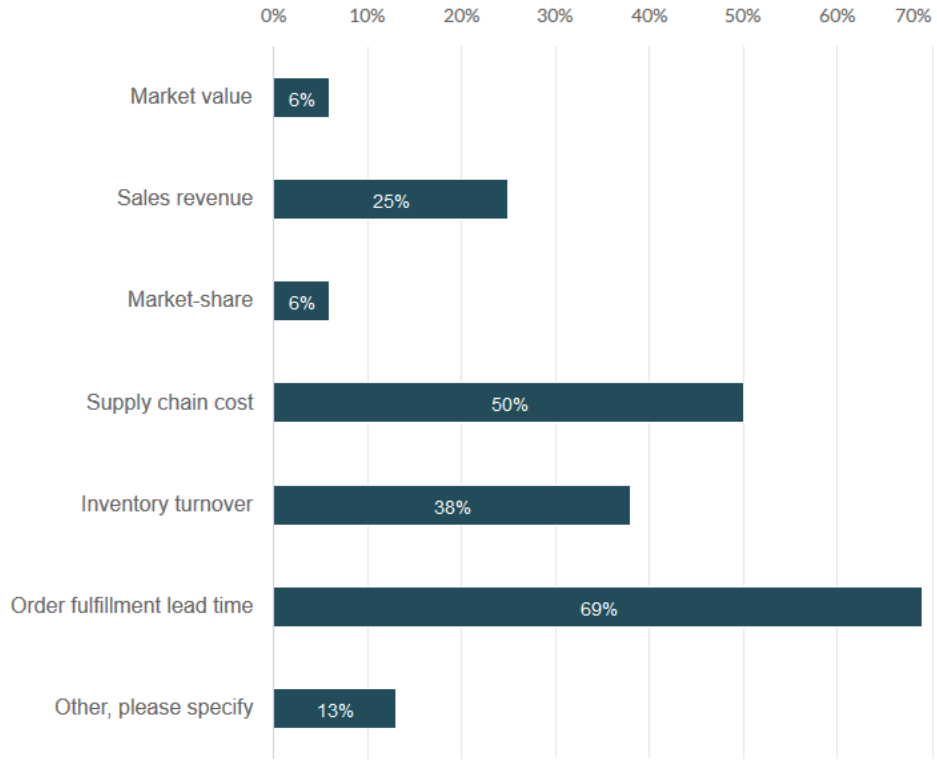

Figure 3: Significant impact on different indicators due to SC disruptions over the past 12 months.

4.1.3. Trends in Supply Chain Risks

Majority of the respondents, 61,1%, believed that the level of protectionism will increase in 2019 compared to the level five years ago. None of the respondents believed that the level of protectionism would decrease. Furthermore, 55,6% of the respondents believed that the level of geopolitical instability will increase in 2019 compared to the level five years ago. 94,4% of the respondents stated that SCRM has become a higher or significantly higher priority to their organization compared to the level five years ago. These figures can be seen in more detail in Table 7.

Protectionism	Increase	11	61,1	61,1	61,1
	Remain the Same	7	38,9	38,9	100,0
	Total	18	100,0	100,0	

Geopolitical instability	Increase	10	55,6	55,6	55,6
	Remain the Same	5	27,8	27,8	83,3
	Decrease	2	11,1	11,1	94,4
	Not Applicable	1	5,6	5,6	100,0
	Total	18	100,0	100,0	

Has supply chain risk management become a higher priority in your organization compared to five years ago?	Significantly higher priority	6	33,3	33,3	33,3
	Higher priority	11	61,1	61,1	94,4
	Remained the same	1	5,6	5,6	100,0
	Total	18	100,0	100,0	

Table 7: Trends in protectionism, geopolitical instability, and importance of SCRM.

4.1.4. SCRM Actions

Majority of the organizations surveyed, 61,1%, are currently deploying an official SCRM strategy. Furthermore, 16,7% of the organizations plan to evaluate deploying an official SCRM strategy within the next 12 months. However, 22,2% of the organizations have no plans at all to deploy an SCRM strategy (Table 8).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No plans to deploy	4	22,2	22,2	22,2
	Plan to evaluate within the next 12 months	3	16,7	16,7	38,9
	Currently deploying	11	61,1	61,1	100,0
	Total	18	100,0	100,0	

Table 8: Organizations deploying an official SCRM strategy.

Most popular currently used SCRM components were sales and operations planning (94,1%), inventory optimization (88,2%), and deeper supplier collaboration (70,6%). Overall, 88,2% of the respondents felt that SCRM has increased their organization's value (Table 9).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	15	83,3	88,2	88,2
	Not being used	1	5,6	5,9	94,1
	Don't know	1	5,6	5,9	100,0
	Total,	17	94,4	100,0	
Missing	-1,00	1	5,6		
Total		18	100,0		

Table 9: Do you feel that SCRM has increased your organization's value?

Figure 4 shows the actions, which the respondents' organizations have taken in SCRM. Based on the results, majority of organizations have taken some proactive measures, such as pursuing deeper supplier collaboration (78%), creating and implementing a business continuity plan (72%), or implementing dual sourcing strategy (67%). However, only 33%, or less, of the respondents were building ability to rapidly adapt their supply, applying hedging strategy against volatility, simplifying complex networks, pursuing diversification strategy, or using business simulations and predictive modelling. Based on the results, most of the organizations are applying only the basic proactive SCRM strategies and could do more in order to improve their SC resilience and flexibility.

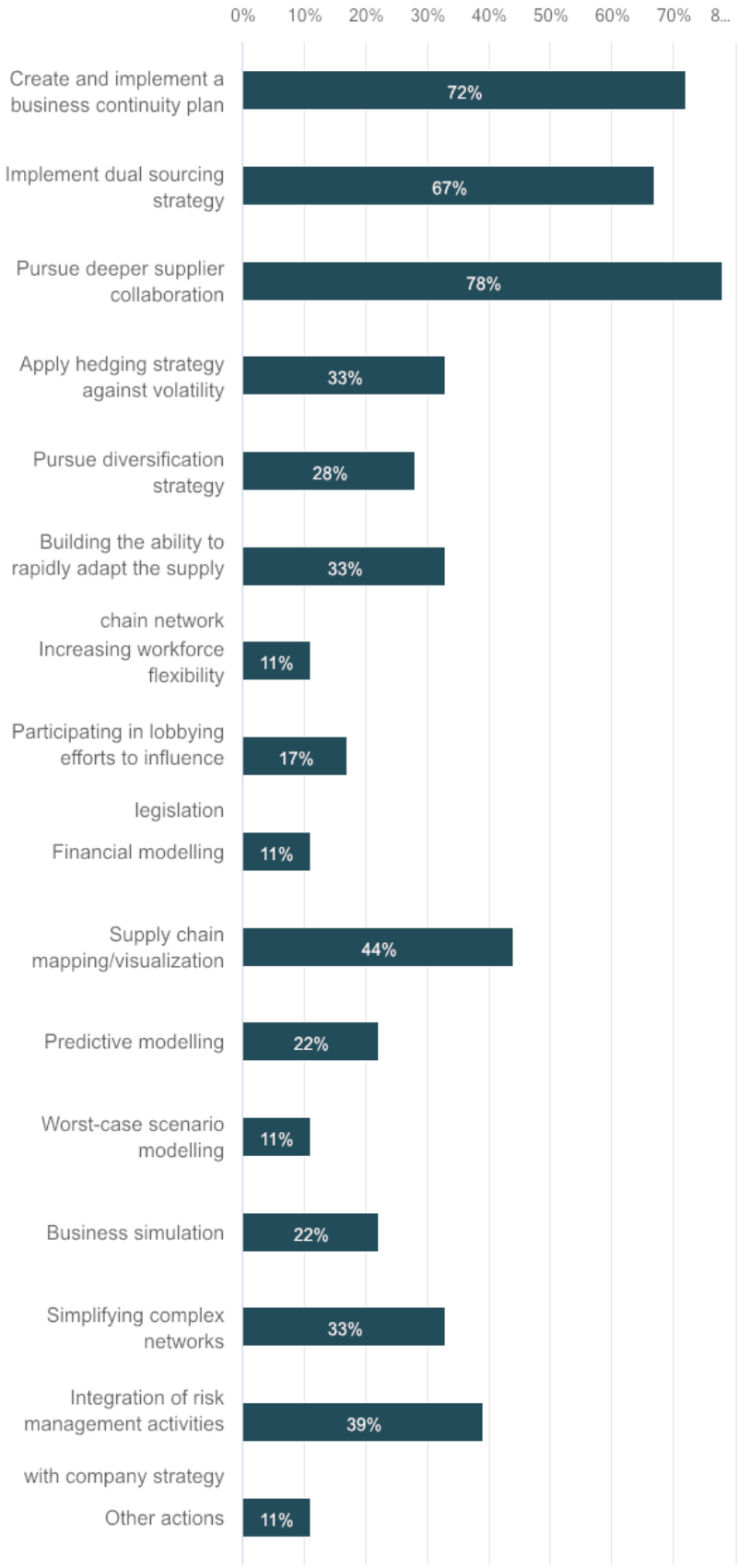

Figure 4: SCRM actions organizations have taken.

When asked which SCRM capabilities were considered the most important, responses varied more. Majority (53%) considered pursuing deeper supplier collaboration as an important capability for their organization. Also, creating and implementing a business continuity plan, implementing dual sourcing strategy, and building the ability to rapidly adapt the supply were considered important capabilities by 41% of the respondents.

On average, respondents felt that different SCRM components were neither effectively or ineffectively managed, receiving average score of approximately 3 on a scale from 1 to 5, one being very ineffectively managed and five being very effectively managed. Price fluctuations, reliability of supply, and meeting contract commitments profitably were considered the most effectively managed, with an average score of 3,58 and a median of 4. Reliance on a single supplier was considered the least effectively managed, with an average score of 2,82. 70,6% of respondents considered their reliance on single supplier as either very ineffectively, ineffectively, or neither effectively or ineffectively managed. The results can be seen in more detail in table 10 and table 11.

		Availability of shared information	Integration along the supply chain	Supply chain visibility	Supply chain collaboration	Reliance on single supplier	Geopolitical risk
N	Valid	17	17	17	17	17	17
	Missing	1	1	1	1	1	1
Mean		3,2941	3,0588	3	3	2,8235	3,0588
Median		4	3	3	3	3	3
Std. Deviation		0,91956	0,74755	0,86603	0,79057	1,13111	1,02899

		Price fluctuations	Reliability of supply	Meeting contract commitments profitably	Overall supply chain cost	Supply chain adaptability to new circumstances
N	Valid	17	17	17	17	17
	Missing	1	1	1	1	1
Mean		3,5882	3,5882	3,5882	3,2941	3,3529
Median		4	4	4	3	3
Std. Deviation		1,00367	0,87026	0,71229	1,0467	0,70189

Table 10: SCRM effectiveness.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	11,1	11,8	11,8
	2	5	27,8	29,4	41,2
	3	5	27,8	29,4	70,6
	4	4	22,2	23,5	94,1
	5	1	5,6	5,9	100,0
	Total	17	94,4	100,0	
Missing	-1,00	1	5,6		
Total		18	100,0		

Table 11: Reliance on single supplier.

Most organizations (7) ranked lack of functional collaboration and lack of SC visibility (7) as two of the greatest challenges for effective SCRM. Considering the results seen in Figure 4, organizations could do more to overcome these challenges. Currently, only deeper supplier collaboration was the only widely used action to address these challenges.

4.1.5. Correlations

Next, a correlation matrix of the whole survey was conducted on SPSS to see whether the responses correlated significantly with each other. Generally, a correlation of ±0,50 to ±1,0 is considered as strong correlation. Also, statistical significance was measured in the matrix. Then, strong correlations with statistical significance were analyzed.

According to the survey, organizations, which had suffered a significant impact on their market value, correlated strongly with the effective management of reliance on single supplier (table 12). Also, according to the survey, increased number of parties in the SC correlates strongly with disruptions in order fulfillment lead time (table 13). Therefore, organizations face challenges in their ability to serve their customers fast as the SC complexity increases.

		Has your organization suffered a significant impact on the performance of the following indicators due to supply chain disruptions over the past 12 months? Market value	In your opinion, how effectively are the following supply chain components managed in your organization? Reliance on single supplier
Has your organization suffered a significant impact on the performance of the following indicators due to supply chain disruptions over the past 12 months? Market value	Pearson Correlation	1	,533*
	Sig. (2-tailed)		,033
	N	16	16
In your opinion, how effectively are the following supply chain components managed in your organization Reliance on single supplier	Pearson Correlation	,533*	1
	Sig. (2-tailed)	,033	
	N	16	17

*. Correlation is significant at the 0.05 level (2-tailed).

Table 12: Positive correlation between significant impact on market value and effective management of reliance on single supplier

		The number of parties in the supply chain has increased	Has your organization suffered a significant impact on the performance of the following indicators due to supply chain disruptions over the past 12 months? Order fulfillment lead time
The number of parties in the supply chain has increased	Pearson Correlation	1	,661**
	Sig. (2-tailed)		,005
	N	18	16
Has your organization suffered a significant impact on the performance of the following indicators due to supply chain disruptions over the past 12 months? Order fulfillment lead time	Pearson Correlation	,661**	1
	Sig. (2-tailed)	,005	
	N	16	16

**. Correlation is significant at the 0.01 level (2-tailed).

Table 13: Positive correlation between increased number of parties in the SC and disruptions in order fulfillment lead time.

According to the survey, organizations, which had suffered a significant impact on their market-share due to SC disruptions correlated positively with considered importance of pursuing diversification strategy (Table 14). Also, organizations, which had suffered a significant impact on their SC cost due to SC disruptions, were pursuing integration of risk management practices with company strategy to eliminate or mitigate risk (Table 15).

		Has your organization suffered a significant impact on the performance of the following indicators due to supply chain disruptions over the past 12 months? Market-share	Which of the following supply chain risk management capabilities do you consider the most important for your organization? Pursuing diversification strategy
Has your organization suffered a significant impact on the performance of the following indicators due to supply chain disruptions over the past 12 months? Market-share	Pearson Correlation	1	,537*
	Sig. (2-tailed)		,032
	N	16	16
Which of the following supply chain risk management capabilities do you consider the most important for your organization? Pursuing diversification strategy	Pearson Correlation	,537*	1
	Sig. (2-tailed)	,032	
	N	16	17

*. Correlation is significant at the 0.05 level (2-tailed).

Table 14: Positive correlation between significant impact on market-share and considered importace of pursuing diversification strategy.

Organizations, which had suffered significant impact on inventory turnover over the past 12 months were now using predictive modelling to eliminate or mitigate risk (Table 16).

		Has your organization suffered a significant impact on the performance of the following indicators due to supply chain disruptions over the past 12 months? Supply chain cost	What actions has your organization taken to eliminate or mitigate supply chain risk? Integration of risk management activities with company strategy
Has your organization suffered a significant impact on the performance of the following indicators due to supply chain disruptions over the past 12 months? Supply chain cost	Pearson Correlation	1	,516*
	Sig. (2-tailed)		,041
	N	16	16
What actions has your organization taken to eliminate or mitigate supply chain risk? Integration of risk management activities with company strategy	Pearson Correlation	,516*	1
	Sig. (2-tailed)	,041	
	N	16	18

*. Correlation is significant at the 0.05 level (2-tailed).

Table 15: Correlation between disruption in SC cost and integration of SCRM activities with company strategy.

		Has your organization suffered a significant impact on the performance of the following indicators due to supply chain disruptions over the past 12 months? Inventory turnover	What actions has your organization taken to eliminate or mitigate supply chain risk? Predictive modelling
Has your organization suffered a significant impact on the performance of the following indicators due to supply chain disruptions over the past 12 months? Inventory turnover	Pearson Correlation	1	,620*
	Sig. (2-tailed)		,010
	N	16	16
What actions has your organization taken to eliminate or mitigate supply chain risk? Predictive	Pearson Correlation	,620*	1
	Sig. (2-tailed)	,010	

modelling	N	16	18

*. Correlation is significant at the 0.05 level (2-tailed).

Table 16: Correlation between significant impact on inventory turnover and predictive modelling.

According to the survey, organizations, which applied hedging strategy against volatility, also pursued diversification strategy and implemented dual sourcing strategy. Interestingly, however, building ability to rapidly adapt the SCN correlated negatively with applying hedging strategy and pursuing diversification (Table 17).

		Apply hedging strategy against volatility	Pursue diversification strategy	Building the ability to rapidly adapt the supply chain network	Implement dual sourcing strategy
What actions has your organization taken to eliminate or mitigate supply chain risk? Apply hedging strategy against volatility	Pearson Correlation	1	,614**	-,500*	,500*
	Sig. (2-tailed)		,007	,035	,035
	N	18	18	18	18
Pursue diversification strategy	Pearson Correlation	,614**	1	-,175	,175
	Sig. (2-tailed)	,007		,486	,486
	N	18	18	18	18
Building the ability to rapidly adapt the supply chain network	Pearson Correlation	-,500*	-,175	1	,000
	Sig. (2-tailed)	,035	,486		1,000
	N	18	18	18	18
Implement dual sourcing strategy	Pearson Correlation	,500*	,175	,000	1
	Sig. (2-tailed)	,035	,486	1,000	
	N	18	18	18	18

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 17: Correlation between applying hedging strategy against volatility, pursuing diversification strategy, building ability to rapidly adapt SC, and implementing dual sourcing strategy.

5. ANALYSIS AND DISCUSSION

This section will analyze and discuss the findings of the survey and reflect them on previous research discussed in literature review. After analysis, general discussion assesses the findings and whether the research objectives of this thesis were achieved. Last, limitations of the research are discussed.

5.1. Analysis of the Findings

According to the reliability analysis of the survey, Cronbach's alpha of 0,66 can be considered statistically reliable, albeit being rather low. The subjective nature of the survey and low inter-relatedness of the questions might have an effect on the internal consistency of the results. Furthermore, since previous research has reached acceptable reliability in similar studies, the findings of this study can be considered reliable.

According to the responses measuring SC complexity, SCs have become more complex over the past three years in general. This is also in line with previous research, as explained in the literature review. Yet, only 33% of the organizations had taken actions to simplify complex SC networks. Based on the findings, the surveyed organizations are more concerned in managing the current complexity, rather than trying to reduce the level of it. On the other hand, organizations might not consider increased SC complexity an issue, in case it is managed well.

However, despite the increased complexity, majority of the respondents considered that SC transparency had not decreased, unlike the literature review would suggest. Furthermore, 83,34% of the respondents agreed or strongly agreed that SC collaboration had increased over the past three years. Reflecting on the conceptual framework, communication and consultation are crucial throughout the risk management process. As discussed in the literature review, communication and collaboration along the SC are also key factors in increasing transparency and managing complex SCs. Therefore, the findings of the survey indicate that the organizations in general seem to have effective communication and collaboration practices within their SCs. Moreover, based on the results, organizations have managed to avoid coordination

problem rather well. Coordination are common in complex SCs due to the lack of visibility.

Majority of the respondents anticipated that protectionism and geopolitical instability would increase during 2019 compared to the level five years ago. Currently, 35,29% of the respondents considered that their geopolitical risk was effectively managed. In general, organizations have very few possibilities to affect these external trends. Therefore, proper SCRM practice, as discussed in the literature review, would be to increase SC resilience and flexibility, since external risks may influence the whole SC. Both SC resilience and flexibility can be increased best through proactive measures, such as pursuing diversification strategy. In general, adoption of a proper SCRM process, such as ISO 31000, would increase SC resilience.

Nonetheless, based on the findings, majority of the organizations were not actively pursuing extensive proactive SCRM practices to tackle these issues. For instance, only 33% of the respondents were building the ability to adapt rapidly their SCN, 28% pursuing diversification strategy, 22% using predictive modeling, and 11% increasing workforce flexibility.

Based on the findings of the survey, 61% of the organizations were currently deploying an official SCRM strategy and 17% of the organizations had plans to evaluate an SCRM strategy within the next 12 months. These findings are in line with previous research. For instance, a research conducted by Deloitte (2013), 66% of organizations had established an official SCRM process. Majority of the respondents were currently deploying some basic proactive measures, such as sales and operations planning (94,12%), inventory optimization (88,24%), strategic sourcing (81,25%), deeper supply chain collaboration (78%), or data management tools (64,71%). Only 22% were using business simulation, and only 11% were using worst-case scenario modelling, despite their benefits in improving SC resilience (Deloitte, 2013; de Oliveira et al., 2014; Christopher, 2018).

These tools help organizations to tackle SC risks on all of the Risk Identification, Analysis, and Evaluation stages of the conceptual framework. These stages are followed by risk elimination, if possible. In addition, tools such as data management

and sales and operations planning improve the Monitoring and Critical Review phase of the framework, which should be used at all stages.

According to the findings of the data-analysis, organizations, which had suffered a significant impact on some of the indicators, such as market-share, SC cost, and inventory turnover, were now deploying proactive SCRM practices, such as diversification strategy, integration of SCRM practices with company strategy, predictive modelling, respectively. Interestingly, an increase in the number of SC parties correlated positively with disruptions in order fulfillment lead time. Therefore, diversification strategies alone might not decrease SC risk. Certainly, effective SCRM requires additional proactive practices to support diversification strategies.

Furthermore, organizations applying hedging strategy against volatility were likely to take other proactive actions as well, such as diversification or dual sourcing strategies. Interestingly, there was a significant negative correlation between applying hedging strategy and building ability to rapidly adapt SC. When asked, which SCRM activities organizations considered most important for them, modelling and simulation tools were not considered particularly important by the respondents.

Based on previous research, SCRM can lead to increased value since risk itself can be seen as a cost. Furthermore, previous research suggests that proactive SCRM practices can also lead to increased value (Dittman et al., 2010, Deloitte, 2013; de Oliveira et al., 2014; Christopher, 2018). Therefore, because SCRM eliminates or reduces risk, its impact on the organizational value is positive.

However, in order to increase organizational value, SCRM should be effective (Neiger et al., 2009; Purdy, 2010; Trkman et al., 2016). When asked the effectiveness of SCRM actions in the respondent's organization, the mean of the responses was approximately three on a scale from 1-5. This indicates, that in majority of the organizations, SCRM practices are neither effectively or ineffectively managed. Effective SCRM can also indicate deeper integration of SCRM practices with company strategy.

However, lack of effective risk management might imply that organizations are experiencing design risk in their SCRM process. According to Park et al. (2013), design risk might result in poor planning and execution of risk assessment, which in turn decreases the effectiveness of SCRM.

Indication of SCRM integration was also found in other findings of the survey. One example is the use of proactive strategies. Proactive measures are generally more expensive than reactive measures and require deeper SCRM coordination. However, since they eliminate or mitigate the SC risk before the risk occurs, they tend to result in better effectiveness, improve the efficiency of the SC, and increase organizational value (Purdy, 2010).

As defined in a report by PwC (2013), organizations can be categorized into four maturity classes (Appendix 2). Majority of organizations fall into level two of the model, being less mature but practicing some integrated buffer planning in their SCRM. Approximately one third of organizations are more mature, practicing collaborative and proactive SCRM. Less than 10% are classified as mature, flexible, and dynamic.

Based on the findings, majority of the surveyed organizations fall into level two of the maturity classification model. Respondents were practicing integrated information sharing and planning activities along their SC. They were also practicing some basic risk management processes, such as dual sourcing. In addition, based on the findings, some organizations were more mature in their SCRM, being more collaborative with their SC partners, creating business continuity plans, using predictive modelling and data management tools, or simplifying complex SC networks.

In conclusion, based on the findings, it can be said that organizations, which had suffered a significant impact on some of the key indicators, were more likely to take proactive SCRM practices. While majority of the respondents considered SCRM being important, and considered that it increases their organizational value, it did not seem to transfer fully to their practices. This seems to be in line with previous research, as discussed in the literature review.

5.2. General Discussion

This thesis aims to answer the research question identified in the introduction through achieving the research objectives. The objectives of this thesis were to:

1. Explore the sources of risk types and their interconnectedness.
2. Analyze risk elimination and mitigating approaches in global supply networks.
3. Examine the basic constructs of risk management.
4. Measure, which risk management strategies are being used in different organizations.
5. Investigate ways of integrating risk management to the daily operations of an organization.

The sources of risk and their interconnectedness were explored both in the literature review and in the survey. As described by Christopher and Peck (2004), risk sources can be divided into three categories: internal to the organization, internal to the SC, and external risks. Based on the findings of the survey, internal risks both to the organization and to the SC were identified. For instance, increased SC complexity, IT disruptions, and failure of company-owned SC operations are examples of internal risks. Also, external risks were identified in the survey, such as regulatory risk, geopolitical instability, or natural disasters. However, significant interconnectedness between the risk types specifically was not found in the data-analysis.

The second objective was to analyze risk elimination and mitigating approaches in SCRM. The literature review analyzed extensively different approaches to SCRM and this thesis used the ISO 31000 model as a theoretical framework. The conceptual framework used in this thesis links risk elimination to the SCRM process and identifies multiple ways to eliminate or mitigate risk. Furthermore, the findings of the survey identified different risk elimination and mitigation practices used in the surveyed organizations. According to the analysis of the findings, it can be concluded that the surveyed organizations were using mostly structured approaches. The analysis of these findings is in line with previous research and adds to the existing knowledge.

The third research objective was to examine basic risk management constructs. The literature review identified and analyzed SCRM approaches and further discussed different phases in the SCRM process. The findings of the survey and analysis sections of this thesis identified and examined the SCRM constructs and their use in practice. Based on the findings, organizations were at varying levels deploying SCRM strategies. While the constructs of risk management were discussed in the literature review, the survey did not focus on any specific part of the SCRM process. Rather, the survey served better in reaching the other objectives.

The fourth objective was to measure, which SCRM strategies different organizations use. The survey was designed to measure this and to which extent organizations were using SCRM. Furthermore, SCRM and its impact on increased company value and competitive advantage were measured by subjective questions. However, the findings did not acknowledge in detail which specific SCRM strategies organizations were deploying. Instead, the findings indicated the type of SCRM strategies organizations were using, such as proactive or reactive strategies.

The last objective was to investigate ways of integrating risk management practices to the daily operations of an organization. Majority of the organizations, 72%, had created a business continuity plan. In addition, 39% of the organizations had integrated SCRM activities with company strategy. These responses reflect that most organizations have integrated SCRM practices with the rest of the organizations to some extent. Majority of the respondents believed that SCRM had increased their organizational value. However, the survey did not provide any qualitative data to support this.

Proactive SCRM practices were measured in multiple questions in the survey, such as in questions 6 and 7 in the questionnaire (Appendix 1). Based on the results, most of the organizations had taken only some essential proactive actions, such as pursuing deeper supplier collaboration. More advanced measures, such as predictive modelling and business simulation were not as widely used.

In conclusion, the research objectives of this thesis were reached. The literature review identified and discussed SC risk sources and their interconnectedness. Fur-

thermore, the literature review analyzed and examined SCRM approaches and constructs. The findings of the survey provided further insight to the same topics. Furthermore, the survey measured the use of different SCRM strategies in organizations and ways of SCRM integration with other company practices.

5.3. Limitations of the Research

As always, this research also has its limitations. A relatively low reliability of the survey indicates that the results are not necessarily consistent. Furthermore, due to the exploratory nature of the survey and a small population, the results cannot be generalized to the entire population. Due to the small sample size, comparison between industries could not be conducted.

There is also a possibility of biased input due to the questionnaire design. For instance, question 6 “What actions has your organization taken to eliminate or mitigate supply chain risk?” assumes that organizations have indeed taken some actions in the first place. Also, question 12 regarding the importance of SCRM is set up in a way, which seems to assume SCRM being important in essence.

Furthermore, the research did not specify between some potentially important factors, such as company size. Larger and wealthier organizations have potentially more resources to use for SCRM. In addition, this research did not specify between respondent’s main geographic operating regions or whether some SC disruptions were prone to any specific areas. Also, differences between organizations headquartered in Finland and elsewhere were not made.

This research did not clarify any reasons why some organizations did not use some specific SCRM processes. Moreover, there were not any questions regarding the way organizations measure their SCRM processes or performance. In addition, SC collaboration was not measured in detail.

Last, this thesis was conducted by an unexperienced author. This means that there might have been unconscious bias when designing and conducting the survey, as

well as when analyzing the findings. Furthermore, the findings of the study might have been influenced by a relatively low experience in data-analysis.

6. CONCLUSION

This section identifies the main findings of this thesis. Second, implications for international business and relevance for SCRM are identified. Last, suggestions for future research are established.

6.1. Main Findings

This thesis was established to identify and analyze SCRM practices in global SCNs. According to the findings, organizations considered their SCs had become more complex over the past three years. Furthermore, they have answered to these changes through proactive measures. In addition, issues related to complexity, such as lack of functional SC collaboration and lack of SC visibility, were mentioned as some of the greatest challenges to their SCRM. The survey also identified external SC risks, which were considered important for SCRM, such as price fluctuations and geopolitical risk.

Significant and strong correlation was found between organizations, which had suffered a significant impact on some of the key indicators and use of proactive SCRM practices. Also, the effectiveness of SCRM actions was identified, leaving room for improvement in most organizations.

Based on the findings of the survey and reflection on previous research, surveyed organizations were identified being either less mature or relatively mature in terms of SCRM. In other words, most of the surveyed organizations had taken some steps in integrating their SCs and were using some proactive SCRM measures. Moreover, some organizations were more advanced and were pursuing deeper collaboration and more proactive SCRM practices.

The findings of this study are in line with previous research, where a majority of organizations believe in the importance of SCRM and have experienced significant impacts on their business because of SC disruptions. Also, majority of organizations view the effectiveness of their SCRM strategies only moderately effective. Despite this, majority of organizations do not spend enough resources in order to achieve effective SCRM, which would increase organization value through flexibility and resilience. In general, the results indicate that organizations remain rather poorly or moderately prepared for SCRM. Therefore, investing in SCRM would provide relatively significant competitive advantage for an organization.

The significance of the main findings is moderate, due to the limitations of the research and since the findings essentially support existing knowledge.

6.2. Implications for International Business

Despite its limitations, the findings of this research contribute to the international business and SCRM in general. The exploratory nature of this study, the implications also serve as a base for future research. The findings of this research add to the previous existing knowledge on SCRM. These results can be transferred globally across different organizations and industries.

As Weingarten (2016) describe it, global SCs are the foundation of global trade. Therefore, managers should pay close attention to identifying trends in global economy that might have an impact on SCs. Moreover, managers should seek ways to improve their SCRM strategies. This thesis has identified some trends in SC risks, which the respondents considered to grow. Also, generally positive attitudes toward SCRM was identified. These findings can also be employed by managers when planning SCRM strategies.

This research adds to the previous research by introducing a perspective from Finnish business environment. Even though all organizations in this study were international, the responses were gathered from representatives based in Finland.

This thesis can be used in evaluating and planning SCRM strategies. The literature review section provides insight on previous research and SCRM process in general, whereas the findings and analysis chapters provide more knowledge on the current state of SCRM in different organizations. Indeed, since the used conceptual framework is not dependent on company size, industry, or geographic region, and the surveyed organizations included ones of different size and industry, the implications can be transferred globally.

6.3. Suggestions for Future Research

Based on the main findings, implications for international business, and limitations of the research, suggestions for future research were identified. First, more research could be done on the ways in which organizations monitor their SCRM processes. Furthermore, ways to measure the impact of SCRM strategies on organization's value could be researched more. Second, reasons for deciding not to deploy certain SCRM practices could be explored. Also, more research on whether some geographic areas or industries are prone to some specific risk types could be conducted.

Third, research with a larger sample size could yield results that are more reliable. Larger sample size could also allow comparison between different organization sizes. Furthermore, it could also allow comparison between and within industries. Also, more detailed research on the use of ISO 31000 standard and its adoption in SCRM could be done.

Finally, similar research avoiding the limitations identified in this thesis could be done. Alternatively, gathering quantitative data from organization's operations, for instance, could provide new perspectives for future research. This could provide more accurate insight on SCRM. Additionally, similar research with different methodology could be conducted. For instance, use of interviews, case studies, or having multiple respondents from the same organization could be more suitable in conducting exploratory research, and provide deeper knowledge on the topic.

REFERENCE LIST

Alvarenga, C. (2012, 9 Nov.) 'Why quants should manage your supply chain' *Harvard Business Review* [Online]. Available from: https://hbr.org/2012/11/why-quants-should-manage-your [Accessed on 2 December 2018].

Aqlan, F. & Lam, S. S. (2015) 'Supply chain risk modelling and mitigation.' *International Journal of Production Research;* 53 (18): 5640-5656. Retrieved from: EBSCOhost Database [Accessed on 9 January 2019].

Christopher, M. (2018) 'The mitigation of risk in resilient supply chains.' *International* Transport Forum Discussion Papers; Leipzig, Germany: 23-25 May. Paris: OECD Publishing. pp. 1-27. Available from: https://doi.org/10.1787/db34fa22-en [Accessed on 6 February 2019].

Christopher, M. & Peck, H. (2004) 'Building the Resilient Supply Chain.' *The International Journal of Logistics Management;* 15 (2): 1-14. Retrieved from: Emerald Insight Database [Accessed on 29 January 2019].

De Oliveira, U. R., Marins, F. A. S., Rocha, H. M. & Salomon, V. A. P. (2017) 'The ISO 31000 standard in supply chain risk management.' Journal of Cleaner Production; 151 (n/a): 616-633. Retrieved from: ScienceDirect Database [Accessed on 29 January 2019].

Deloitte Development LLC. (2013) *The ripple effect: how manufacturing and retail executives view the growing challenge of supply chain risk*. Available from: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/strategy/us-consulting-therippleeffect-010515.pdf [Accessed on 10 February 2019].

Dittman, P. J., Slone, R. & Mentzer, J. T. (2010, 5 Feb.) 'Supply chain risk: it's time to measure it.' *Harvard Business Review* [Online]. Available from: https://hbr.org/2010/02/is-your-supply-chain-at-risk-1 [Accessed on 2 December 2018].

Fan, Y. & Stevenson, M. (2018) ’A review of supply chain risk management: definition, theory, and research agenda.’ *International Journal of Physical Distribution & Logistics Management;* 48 (3): 205-230. Retrieved from: Emerald Insight Database [Accessed on 31 January 2019].

Hachicha, W. & Elmsalmi, M. (2014) ‘An integrated approach based-structural modeling for risk prioritization in supply network management.’ *Journal of Risk Research;* 17 (10): 1301-1324. Retrieved from: Taylor & Francis Online Database [Accessed on 30 January 2019].

Hillman, M. & Keltz, H. (2007) *Managing risk in the supply chain – a quantitative study* [Online]. AMR Research. Available from: http://www.scrlc.com/articles/AMR_Managing_Risk.pdf [Accessed on 10 February 2019].

Ho, W., Zheng, T., Yildiz, H. & Talluri, S. (2015) ’Supply chain risk management: a literature review.’ *International Journal of Production Research;* 53 (16): 5031-5069. Retrieved from: Taylor & Francis Online Database [Accessed on 29 January 2019].

Jajja, M. S. S., Chatha, K. A. & Farooq, S. (2018) ‘Impact of supply chain risk on agility performance: Mediating role of supply chain integration.’ *International Journal of Production Economics;* 205 (11): 118-138. Retrieved from: ScienceDirect Database [Accessed on 9 January 2019].

Jüttner, U., Peck H., & Christopher M. (2003) ‘Supply chain risk management: outlining an agenda for future research.’ *International Journal of Logistics: Research and Applications*; 6 (4): 197-210. Retrieved from: Taylor & Francis Online Database [Accessed on 2 December 2018].

Jüttner U. & Maklan S. (2011) ‘Supply chain resilience in the global financial crisis: an empirical study.’ *Supply Chain Management: An International Journal;* 16 (4): 246-259. Retrieved from: Emerald Insight Database [Accessed on 2 December 2018].

Manuj, I. & Mentzer, J. T. (2008) 'Global supply chain risk management strategies.' *International Journal of Physical Distribution & Logistics Management*; 38 (3): 192-223. Retrieved from: Emerald Insight Database [Accessed on 2 December 2018].

McKinnon, A. (2014) 'Building supply chain resilience: a review of challenges and strategies.' *Report for the Joint APEC – ITF Supply Chain Resilience Workshop;* Christchurch, New Zealand: 26-28 March. Paris: OECD Publishing. pp. 1-25. Available from: https://doi.org/10.1787/5jrw2z6nnxlq-en [Accessed on 6 February 2019].

Min, H. (2019) 'Blockchain technology for enhancing supply chain resilience.' *Business Horizons;* 62 (1): 25-45. Retrieved from: ScienceDirect Database [Accessed on 9 January 2019].

Neiger, D., Rotaru, K. & Churilov, L. (2009) 'Supply chain risk identification with value-focused process engineering.' *Journal of Operations Management;* 27 (2): 154-168. Retrieved from: ScienceDirect Database [Accessed on 29 January 2019].

Park, A., Nayyar, G. & Low, P. (2013) *Supply chain perspectives and issues: a literature review.* Lausanne: WTO Publications. Available from: https://www.wto.org/english/res_e/booksp_e/aid4tradesupplychain13_e.pdf [Accessed on 6 February 2019].

Pfohl, H., Kohler, H. & Thomas, D. (2010) 'State of the art in supply chain risk management research: empirical and conceptual findings and a roadmap for the implementation in practice.' *Logistics Research;* 2 (1): 33-44. Retrieved from: Springer Link Database [Accessed on 28 January 2019].

Prakash, S., Gunjan, S. & Ajay, P. S. R. (2017) 'A critical analysis of supply chain risk management content: a structured literature review.' *Journal of Advances in Management Research*; 14 (1): 69-90. Retrieved from: Emerald Insight Database [Accessed on 30 January 2019].

Purdy, G. (2010) 'ISO 31000:2009 – Setting a new standard for risk management' *Risk Analysis;* 30 (6): 881-886. Retrieved from: EBSCOhost Database [Accessed on 16 March 2019].

PwC (2013) *Supply chain and risk management* [Online]. Available from: https://www.pwc.com/gx/en/operations-consulting-services/pdf/pwc-supply-chain-and-risk-management.pdf [Accessed on 10 February 2019].

Rangel, A. D., de Oliveira, T. K. & Leite, M. S. (2015) 'Supply chain risk classification: discussion and proposal.' *International Journal of Production Research*; 53 (22): 1-20. Retrieved from: Taylor & Francis Online Database [Accessed on 9 January 2019].

Revilla, E. & Sáenz, M. J. (2014) 'Supply chain disruption management: global convergence vs national specificity.' *Journal of Business Research;* 67 (6): 1123-1135. Retrieved from: ScienceDirect Database [Accessed on 16 March 2019].

Saunders, M., Lewis, P. & Thornhill, A. (2007) *Research methods for business students* (4th edition) [ProQuest Ebook Central]. UK: Pearson Education.

'Slowbalisation' (2019, 26 Jan.) *The Economist.* p. 9.

'The global list' (2019, 26 Jan.) *The Economist.* p. 17-20.

Tohamy, N. (2008) 'Can technology handle supply chain risk?' *Supply Chain Management Review*; 12 (5): (n/a). Retrieved from: ProQuest Database [Accessed on 2 December 2018].

Trkman, P., de Oliveira, M. P. V. & McCormack, K. (2016) 'Value-oriented supply chain risk management: you get what you expect.' *Industrial Management & Data Systems*; 116 (5): 1061-1083. Retrieved from: Emerald Insight Database [Accessed on 2 December 2018].

Tummala, V. M. R. & Schoenherr, T. (2011) ’Assessing and managing risks using the supply chain risk management process (SCRMP).’ *Supply Chain Management: An International Journal;* 16 (6): 474-483. Retrieved from: ResearchGate Database [Accessed on 14 December 2018].

The United States of America: Department of Defense (2012) *Department of defense Standard Practice System Safety.* N/A. Available from: https://quicksearch.dla.mil/WMX/Default.aspx?token=5715775 [Accessed on 29 January 2019].

Wiengarten, F., Humphreys, P., Gimenez, C., McIvor, R. (2016) ‘Risk, risk management practices, and the success of supply chain integration’ *International Journal of Production Economics*; 171: 361-370. Retrieved from: ScienceDirect Database [Accessed on 16 March 2019].

APPENDICES

Appendix 1: Survey on Supply Chain Risk Management

Survey on Supply Chain Risk Management

You are invited to participate in survey conducted as a part of a Bachelor's thesis in Aalto University School of Business. The purpose of this survey is to collect information about Supply Chain Risk Management. Your responses are anonymous and confidential. Answers are used for scholarly purposes only. The survey will take approximately 10-15 minutes.

Thank you for your participation!

1. Please answer the following questions regarding the development of supply chain complexity over the past three years.

	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
Dependencies between supply chain parties have increased	○	○	○	○	○
Changes in supply chain configuration occur more frequently	○	○	○	○	○
The number of parties in the supply chain has increased	○	○	○	○	○
The relationships between supply chain parties have become less transparent	○	○	○	○	○
Collaboration between supply chain parties has increased	○	○	○	○	○

2. In your opinion, what are the 1st, 2nd, and 3rd most important risks for your organization?

	Ranked 1	Ranked 2	Ranked 3
Supplier failure	○	○	○
Border delays	○	○	○
Failure of company-owned supply chain operations	○	○	○
Price fluctuations	○	○	○
Natural disasters	○	○	○
Geopolitical instability	○	○	○
Corruption	○	○	○
Changes in regulations	○	○	○
Strategic risk	○	○	○
Intellectual property theft or infringement	○	○	○
IT disruptions	○	○	○
Cyber attacks	○	○	○
Other	○	○	○

3. Has your organization suffered a significant impact on the performance of the following indicators due to supply chain disruptions over the past 12 months? You may choose multiple options.

- ☐ Market value
- ☐ Sales revenue
- ☐ Market-share
- ☐ Supply chain cost
- ☐ Inventory turnover
- ☐ Order fulfillment lead time
- ☐ Other, please specify

4. In your opinion, do you believe that the level of supply chain risk in 2019 is increasing, staying the same, or decreasing compared to the level five years ago?

	Increase	Remain the Same	Decrease	Not Applicable
Supplier failures	○	○	○	○
Cost increases	○	○	○	○
Natural disasters	○	○	○	○
Intellectual property infringement	○	○	○	○
Protectionism	○	○	○	○
Geopolitical instability	○	○	○	○
Cyber attacks	○	○	○	○
	○	○	○	○

5. Has supply chain risk management become a higher priority in your organization compared to five years ago?

- ○ Significantly higher priority
- ○ Higher priority
- ○ Remained the same
- ○ Lower priority
- ○ Significantly lower priority

6. What actions has your organization taken to eliminate or mitigate supply chain risk? You may choose multiple options.

- ☐ Create and implement a business continuity plan
- ☐ Implement dual sourcing strategy
- ☐ Pursue deeper supplier collaboration
- ☐ Apply hedging strategy against volatility
- ☐ Pursue diversification strategy
- ☐ Building the ability to rapidly adapt the supply chain network
- ☐ Increasing workforce flexibility
- ☐ Participating in lobbying efforts to influence legislation
- ☐ Financial modelling
- ☐ Supply chain mapping/visualization
- ☐ Predictive modelling
- ☐ Worst-case scenario modelling
- ☐ Business simulation
- ☐ Simplifying complex networks
- ☐ Integration of risk management activities with company strategy
- ☐ Other actions

7. Which of the following supply chain risk management capabilities do you consider the most important for your organization? You may choose multiple options.

- ☐ Creating and implementing a business continuity plan
- ☐ Implementing dual sourcing strategy
- ☐ Pursuing deeper supplier collaboration
- ☐ Applying hedging strategy against volatility
- ☐ Pursuing diversification strategy
- ☐ Building the ability to rapidly adapt the supply chain network
- ☐ Increasing workforce flexibility
- ☐ Participating in lobbying efforts to influence legislation
- ☐ Financial modelling
- ☐ Supply chain visualization
- ☐ Predictive modelling
- ☐ Worst-case scenario modelling
- ☐ Business simulation
- ☐ Simplifying complex networks
- ☐ Integration of risk management activities with company strategy
- ☐ Other actions

8. In your opinion, how effectively are the following supply chain components managed in your organization on a scale from 1-5?
1= Very ineffectively managed 5= Very effectively managed

	1	2	3	4	5	Not Applicable
Availability of shared information	○	○	○	○	○	○
Integration along the supply chain	○	○	○	○	○	○
Supply chain visibility	○	○	○	○	○	○
Supply chain collaboration	○	○	○	○	○	○
Reliance on single supplier	○	○	○	○	○	○
Geopolitical risk	○	○	○	○	○	○
Price fluctuations	○	○	○	○	○	○
Reliability of supply	○	○	○	○	○	○
Meeting contract commitments profitably	○	○	○	○	○	○
Overall supply chain cost	○	○	○	○	○	○
Supply chain adaptability to new circumstances	○	○	○	○	○	○

9. In your opinion, what are the 2 greatest challenges to effectively managing supply chain risk?

	Ranked 1	Ranked 2
Lack of functional collaboration	○	○
Cost of implementing supply chain risk management strategies	○	○
Inability to measure the benefits of supply chain risk management	○	○
Lack of clear governance of supply chain risk	○	○
Lack of required data to support decision-making	○	○
Lack of supply chain visibility	○	○
Lack of supply chain flexibility	○	○
Other	○	○

10. Does your organization deploy an official supply chain risk management strategy?

- ○ No plans to deploy
- ○ Plan to evaluate within the next 12 months
- ○ Plan to implement within the next 12 months
- ○ Currently deploying

11. Which of the following risk management components do you use today or plan to implement?

	Use today	Plan to implement in 12 months	No plans	Not applicable
Sales and operations planning	○	○	○	○
Inventory optimization	○	○	○	○
Analytics tool for performance management	○	○	○	○
Supply chain visibility tools	○	○	○	○
Strategic sourcing	○	○	○	○
Predictive modelling tools	○	○	○	○
Worst-case scenario modelling	○	○	○	○
Supply chain network design tools	○	○	○	○
Data management tools	○	○	○	○
Deeper supply chain collaboration	○	○	○	○

12. In your opinion, how important is supply chain risk management in strategic decision-making?

Not important	Somewhat important	Important	Very important
○	○	○	○

13. Do you feel that supply chain risk management has increased your organization's value?

- ○ Yes
- ○ No
- ○ Not being used
- ○ Don't know

14. How does your organization fund supply chain risk management operations?

- ○ Through a specific supply chain risk management budget
- ○ Through a general operations budget
- ○ Through a general IT budget
- ○ Through a general finance budget
- ○ Other

15. In which industry does your organization operate?

- ○ Industrial Products
- ○ Technology and Telecommunications
- ○ Retail and Consumer Goods
- ○ Service Industries
- ○ Pharmaceuticals and Chemicals
- ○ Energy and Resources
- ○ Aerospace and Defense
- ○ Other

16. Are there any comments you would like to make?

Appendix 2: SCRM Maturity Levels (adapted from PwC, 2013)

	Supply Chain Management	Risk Management	
Level 1	**Functional** Limited collaboration within the SC, no integrated plans	**Ad-hoc** Lack of SC visibility, endures only limited volatility	**Less Mature**
Level 2	**Integrated** Internal information sharing and planning. Key resources and objectives are managed together	**Buffer planning** Buffers based on a common plan, basic risk management processes, lack of visibility into external changes	
Level 3	**Collaborative** Visibility, information sharing, and integration of activities between SC parties	**Proactive** Use of predictive measures, business continuity plans, SC partner monitoring, quantitative SCRM	**More Mature**
Level 4	**Dynamic** Ability to adapt the SC to frequent changes, integration of SC trends in complex environments, SC segmentation	**Flexible** Investments in SC flexibility, SCRM strategy segmentation, SCRMmonitoring and critical review	